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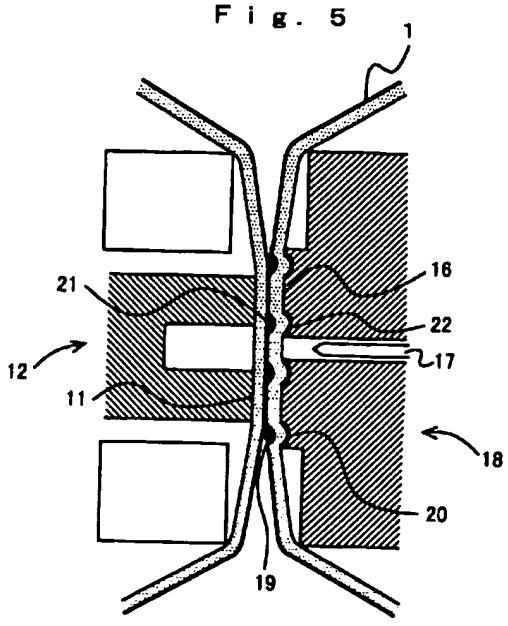
(54) Ultrasonic sealing apparatus

(57) To provide an ultrasonic sealing apparatus with an excellent sealability capable of: positively discharging contaminants such as juice pulp from sealing zones together with molten thermoplastic resin; and preventing a formation of the undulated molten resin beads by controlling the thickness and the width of the molten resin that flows out to the side in contact with a fluid.

In an apparatus wherein a packing material consisting of a laminated body (1) comprising the thermoplastic resin layers is made into a tubular form and the tubular packing material is transverse-ultrasonically sealed with a fluid, a horn (12) with an elongated and flat sealing face, and grooves which can form the molten thermoplastic resin bulges in the vicinal area of the side of the sealing zones on the action face of the opposing jaw in contact with a fluid pressing the packing material in cooperation with the sealing face of the said horn, are disposed. Further, disposing grooves which can form the molten resin bulges in the vicinal area of the cutting side of sealing zones or an incline to allow the molten resin to flow out of sealing zones to the cutting side on the action face of the opposing jaw, is desirable.

Fig. 5



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Description

CROSS REFERENCE TO RELATED APPLICATIONS

[0001] Priority is claimed with respect to Japanese Application No. 279917/1999 filed September 30, 1999, in the Japanese Patent Office, the disclosure of which is incorporated herein by reference.

BACKGROUND OF THE INVENTION

1. Field of the Invention:

[0002] The present invention relates to an ultrasonic sealing apparatus for use in a filling/packing machine for producing liquid beverages or the like, which are packed in paper containers so that they can be stored for a long time, and more particularly to an ultrasonic sealing apparatus provided with an opposing jaw having an action face of a specific shape for improving sealability by controlling molten thermoplastic resin flow.

2. Description of the Related Art:

[0003] Hitherto, there has been known a filling/packing machine, as a whole shown in Fig. 1, in which a sterilized packing material web is used for a rectangular parallelepiped packing container filled with a juice, etc. In brief, such a filling/packing machine as a whole comprises a reel 2 supporting a laminated packing material web 1 in a rolled state; a sterilization device 3 for sterilizing the tabular laminated packing material web successively unwound from the reel; a longitudinal sealing section 4 for sealing both longitudinal end portions of the sterilized laminated packing material web and thereby forming a tubular laminated packing material web; a liquid supply tube 5 for filling a fluid content into the web formed into the tubular form; a transverse sealing device 7 for transversely sealing the tubular laminated packing material web in the direction perpendicular to the longitudinal direction thereof with a fluid while feeding downward the tube filled with the content by the length substantially corresponding to one package, and at the same time, continuously forming a pillow-shaped container 6 which is rectangular in section; and a container shaping device for forming the pillow-shaped containers 6 into rectangular parallelepiped containers 8 by folding the end portions to make the final form. The transverse sealing device 7 is composed of a sealing unit, a sealing jaw for fixing the sealing unit, and a driving means for driving the sealing jaw.

[0004] Such a sealing apparatus may comprise an ultrasonic sealing device in the form of a piezoelectric driving unit with a piezoelectric ceramic plate or a magnetostriction driving unit, which is connected to an AC supply source, and a horn with an elongated sealing surface, with one or more reaction bodies forming a half wavelength together with the horn (Japanese Laid-Open Patent Application No. 2231/1995). In addition, other ultrasonic sealing apparatuses are known, for example as disclosed in Japanese Patent Publication No. 22784/1987, Japanese Patent Publication No. 2544450/1996, Japanese Laid-Open Patent Application No. 33121/1995, Japanese Laid-Open Patent Application No. 92046/1981. Japanese Laid-Open Patent Application No. 15741/1994, and the like.

[0005] Among the other ultrasonic sealing apparatuses, there has been known an ultrasonic sealing apparatus for liquid containers that is characterized by the shape of the action face of the opposing jaw for pressing the laminated packing material in cooperation with the sealing face of the horn. In this apparatus, a band-shaped ridge is disposed nearly at the center of the face of the horn butting against the portion to be sealed. A concave groove perpendicular to the ridge is disposed nearly at the center of the face of an anvil butting against the portion to be sealed. A bottom portion of the concave groove is made into a two-step structure and its step portion and both end portions are tapered. An acute-shaped protruded slant face extending sideward is provided at the end portion of the center of the bottom portion. The open portions at the top and bottom ends of a cylindrical liquid container are sealed with an overlapping bonding portion approximately at the center of the body consisting of the horn and opposing jaw or anvil (see Japanese Laid-Open Utility Model Application No. 147408/1988 and Registered Utility Model No. 3004786).

[0006] On the other hand, there is known a high-frequency heat sealing apparatus (Japanese Laid-Open Patent Application No. 230834/1996), wherein the molten resin remains in grooves without flowing out of the sealed zones, even if the resin on the packing material is melted and pushed by a ridge. In this arrangement, the ridge is formed in the longitudinal direction of an action face and high-frequency coils are used with the grooves formed parallel to the ridge on both sides of the ridge on the high-frequency heat sealing apparatus. There is additionally known a high-frequency heat sealing apparatus (Japanese Patent Publication No. 244728/1996), wherein the high-frequency coils are formed to incline gradually toward the outer (i.e., to the container'S interior side) of the sealed zone forming portion. In this arrangement, the heat sealing is done such that liquid and the molten resin are discharged smoothly from the sealed zones to the container's interior side when the tube is pressed together with a fluid on the high-frequency heat sealing apparatus.

[0007] In order to achieve an excellent heat sealing when transversely heat sealing a tubular packing material filled with contents such as liquid beverages, i.e. in the presence of the liquid, it is necessary to exclude the liquid from the sealed zones of the tube as much as possible when the tube is sealed with heat and under pressure. However, the tube inner face in contact with

the liquid is not necessarily completely flat and has small asperities, if observed in detail. In the high-frequency heat sealing apparatus disclosed in Japanese Laid-Open Patent Application Nos. 134744/1983, 269854/1993, 164523/1995, 240607/1997 and 230834/1996, a sealing method is employed in which the molten resin can be prevented from flowing out of the sealed zone and thus is left in the sealed zones. As a result, liquid or dirt enters the small asperities of the tube inner face and cannot be discharged to the outside of the sealed zones, so that the sealing property cannot be said to be adequate.

[0008] On the other hand, the inventors of the present invention have discovered that the liquid in the sealed zones may be guided to flow out of the sealed zones together with the molten resin so as to eliminate the liquid or dirt entered into the asperities when sealed, as disclosed in Japanese Laid-open Patent Appliction No. 244728/1996. The method using this heat sealing apparatus can completely eliminate liquid or dirt entering into the asperities to provide excellent sealing properties, but the molten resin flowing out to the side in contact with a fluid, which is the container's interior side, may not homogeneously extrude. As shown in Fig. 2, undulated molten resin beads 9 are formed on the edge portion of the container's interior side. At the secondary step using a shaping machine and the like after the sealing step, it has been found out that cracks start from crests 10 of the undulations of the beads 9 and allow liquid leakage when pressure is applied to the container, although such leakage is quite infrequent. Problems with the high-frequency sealing apparatus are expected to occur almost similarly with the ultrasonic sealing apparatus, even considering the particularity of the ultrasonic sealing apparatus.

[0009] As to the particularity of the ultrasonic sealing apparatuses, i.e. the distinction from the high-frequency sealing apparatuses, the inventors of the present invention gained an insight as follows by preliminary experiments. In pressing the tubular packing material with an ultrasonic horn and an opposing jaw working together on the ultrasonic sealing apparatus, it was found that keeping the uniformity of the pulsation would be difficult, if configurations such as the grooves and an incline which increase the sealability are added on the sealing face of the ultrasonic horn, due to the additional asperities. Thus it would be impossible to apply an appropriate pressure on the intended sealing area of the tubular packing material. Further, in the case of ultrasonic sealing, as opposed to high-frequency sealing which can heat even the unpressed area, it was determined that a portion of the molten thermoplastic resin inevitably flows out to the side in contact with the fluid which is on the container's interior, because only the pressed area, which infallibly transmits the ultrasonic pulsation, is heated.

SUMMARY OF THE INVENTION

[0010] An object of the present invention is to provide an ultrasonic heat sealing apparatus having excellent sealability and which is capable of: infallibly applying pulsation by an ultrasonic wave generating device to zones to be sealed, sufficiently heating even the step portions around the longitudinal sealing portion, positively discharging contaminants such as juice pulp existing in the zones being sealed from the sealing zones together with the molten thermoplastic resin, and preventing formation of undulated molten resin beads by controlling the thickness and the width of the molten thermoplastic resin flowing out to the side in contact with the fluid contents.

[0011] In order to accomplish the above objects, the inventors of the present invention found that forming a structure which controls the flow of the molten thermoplastic resin on the action face of the opposing jaw, but not on the sealing face of the horn, makes it possible to infallibly apply the pulsation by an ultrasonic wave generating device to the zones to be sealed. Further, by disposing the grooves on the action face of the opposing jaw which can form the molten thermoplastic resin bulges in the vicinal areas of the sides of the sealing zones in contact with a fluid makes it possible to positively discharge contaminants from the sealing zones together with the molten thermoplastic resin and to control the thickness and the width of the molten thermoplastic resin flowing out to the side in contact with a fluid. The invention is based on these principles.

[0012] Namely, the present invention relates to an ultrasonic sealing apparatus, comprising a horn having an elongated and flat sealing face and an opposing jaw having an action face comprising a pressing portion for pressing packing material in cooperation with the sealing face of the horn, and at least grooves are disposed on the action face of the opposing jaw, capable of forming the molten thermoplastic resin bulges in the vicinal areas of the sides in contact with a fluid of the sealing zones on the apparatus wherein a packing material comprising a laminated body containing at least a thermoplastic resin layer is formed into a tubular form and the tubular packing material is transversely ultrasonically sealed with a fluid on the apparatus (claim 1); an ultrasonic sealing apparatus according to claim 1, wherein grooves are disposed on the action face of the opposing jaw, which can form the molten thermoplastic resin bulges in the vicinal areas of the cutting sides of the sealing zones(claim 2); an ultrasonic sealing apparatus according to claim 1, wherein an incline is disposed on the action face of the opposing jaw, which can allow the molten thermoplastic resin to flow out of the sealing zones to a cutting side (claim 3); an ultrasonic sealing apparatus according to any of claims 1 to 3, wherein the width of the pressing portion is narrower than the width of the sealing face by the grooves and/or an incline (claim 4); an ultrasonic sealing apparatus

according to claims 1, 2 or 4, wherein the grooves are arcuate in cross section comprising a depth smaller than one half of the width (claim 5); an ultrasonic sealing apparatus according to any of claims 1 to 5, wherein the laminated body comprises paper layers (claim 6); an ultrasonic sealing apparatus according to any of claims 1 to 6, wherein the opposing jaw comprises a cutting device (claim 7); and an ultrasonic sealing apparatus according to any of claims 1 to 7, wherein the tubular packing material is a tubular packing material formed into a tubular form with a sealing tape when the packing material is formed into the tubular form (claim 8).

[0013] In accordance with the invention, any laminated body containing a thermoplastic resin layer such as polyethylene as an inmost face capable of being heat sealed by means of heating may be used as the packing material comprising a laminated body containing at least the thermoplastic resin layer. However, one with paper layers such as a paper sheet for maintaining a rigidity of the container is desirable. It is also possible to use laminated bodies comprising an aluminum foil layer or an oxygen-impermeable synthetic resin film layer for preventing air, microbes or the like from permeating into the container. As the tubular packing material of the present invention, it is possible to use a packing material which is made into a tubular form using a sealing tape, in addition to a packing material made into the tubular form.

[0014] In the present invention, the apparatus in which the packing material formed into the tubular form is transversely ultrasonic sealed with a fluid may comprise any ultrasonic sealing apparatus so long as it comprises a horn having an elongated and flat sealing face, an opposing jaw having an action face including a pressing portion for pressing the packing material in cooperation with the sealing face of the horn, and grooves disposed on the action face of the opposing jaw which can form the molten thermoplastic resin bulges in the vicinal area of the side of the sealing zones in contact with the fluid. It is thus possible to use a conventional ultrasonic sealing apparatus aside from the grooves being disposed on the action face of the opposing jaw.

[0015] For example, it is possible to concretely exemplify the ultrasonic sealing apparatus developed by the inventors of the present invention, as shown in Fig. 3, wherein there is provided at least one horn 12 with two elongated and flat sealing faces 11 for sealing the packing material in the longitudinal direction, plural converters 13 standing on the opposite side of the sealing faces of the horn 12, which resonate the horn, and a sealing jaw whose length is the length of one wavelength, and whose fixing position (attaching flange) 14 is a nodal plane. According to another embodiment of the invention shown in figure 4, the ultrasonic sealing apparatus may comprise plural converters 13 provided standing on one horn-fixture integral, unitary body 15 which comprises one elongated and flat sealing face 11, for sealing the packing material in the longitudinal direction (WO99/48759). By using these ultrasonic sealing apparatuses with plural converters 13, it becomes possible to uniformly heat seal over the entire elongated sealing face including both end portions.

[0016] The sealing zones (or the sealed zones) in the present invention refer to the portions heat sealed from heat loaded by pressure and mechanical vibration onto the thermoplastic resin layer, which is the inmost face of the packing material, caused by the elongated and flat sealing face disposed on the edge of the horn and by the pressing portion pressing the packing material in corporation with the sealing face of the horn existing on the action face of the opposing jaw. Further, the intended portions to be heat sealed may be referred to as the sealing zones (or the sealed zones) as a matter of convenience. Therefore, the sealing zones are generally concordant with the pressing portions, thus making the vicinal area in the side in contact with a fluid, and the vicinal area of the cutting side where the packing container is to be cut off, to be formed on both outer sides of the sealing zones; and the sealed zones are continuously formed by using the ultrasonic sealing apparatus of the present invention. That is to say, in this kind of filling/packing machine comprising the ultrasonic sealing apparatus, generally two pairs of pressing members each comprising the sealing jaw and the opposing jaw are used; the two sealed zones are continuously formed by being heat sealed with the respective pairs of pressing members; and packing containers each formed into the pillow-shape are to be cut off between the two sealed zones.

[0017] The character of the ultrasonic sealing apparatus of the present invention is that the grooves that form the molten thermoplastic resin bulges in the vicinal area of the side of the sealing zones in contact with a fluid, are at least disposed on the action face of the opposing jaw. Namely, the molten thermoplastic resin bulges are formed in the vicinal area of the side of the sealing zones in contact with a fluid, by grooves disposed on the action face of the opposing jaw. It is also possible to rephrase the grooves as grooves disposed on the non-pressing portions adjacent to the side of the pressing portion of the action face in contact with a fluid along with the pressing portion in its longitudinal direction. The best modes of the invention are the ultrasonic sealing apparatus wherein grooves that form the molten thermoplastic resin bulges are disposed in the vicinal area of the cutting side of the sealing zones on the action face of the opposing jaw in addition to grooves on the non-pressing face portion of the side in contact with a fluid, and the ultrasonic sealing apparatus wherein an incline is disposed in the vicinal area of the cutting side of sealing zones on the action face of the opposing jaw for the molten thermoplastic resin to flow out toward the direction away from the sealing zones.

[0018] If grooves are disposed on the action face of the opposing jaw, which can form the molten thermo-

plastic resin bulges in the vicinal area of the side in contact with a fluid or the vicinal area of the cutting side of the sealing zones, there provided excellent heat sealing to the sealing zones which does not have contaminants in the sealing zones, due to the thermoplastic resin in the sealing zones, which was melted by the pressure and the heat, being discharged out of the sealing zones at the time of ultrasonic heat sealing. Additionally, the undesirable formation of the undulated molten resin beads can be prevented due to the molten thermoplastic resin flowing out of the sealing zones at the side in contact with a fluid, and forming molten thermoplastic resin bulges with constant width and thickness in the vicinal area of the side of the sealing zones in contact with a fluid. Further, cutting becomes easy because the molten thermoplastic resin that flows out of the sealing zones of the cutting side forms molten thermoplastic resin bulges with constant width and thickness in the vicinal area of the cutting side of the sealing zones, and does not flow out to the cutting portion.

[0019] Any form of groove suffices for the grooves disposed on the action face of the opposing jaw, so long as the molten thermoplastic resin does not flow over the grooves toward the side in contact with a fluid. Desirably, the groove is provided with a structure in which the edge of the side of molten thermoplastic resin bulges in contact with the fluid becomes straight. For example, grooves with a shape such as a U-shape in cross section, V-shape in cross section, arcuate in cross section, are exemplary; and grooves which are arcuate in cross section with a depth smaller than one half of the width, for example, approximately one third are more desirable. Equally, it is desirable to preset the width and the depth of the grooves so that grooves are filled with the molten thermoplastic resin that flows out, and the molten thermoplastic resin bulges with sealed edges of uniform width. Cracks are not caused by the resulting molten thermoplastic resin bulges of uniform width, so that fractures from the ridge of the resin by an internal pressure of the container can be prevented.

[0020] Further, in lieu of the grooves disposed on the cutting side exterior of the pressing portion of the action face, it is also possible to provide excellent heat sealing without any contaminant in the sealed zone, by forming an incline on the action face of the opposing jaw for the molten thermoplastic resin to flow out toward the direction away from sealing zones, so that the molten thermoplastic resin in the sealing zones smoothly flows out of the cutting side of the sealing zones. Additionally, by so disposing the incline, the flow of the molten thermoplastic resin going out of the side of the sealing zones in contact with a fluid can be controlled; especially the flow at the longitudinal sealing portion where the sealing tape melts can be controlled, thus preventing the molten thermoplastic resin from flowing over the grooves disposed on the side of the action face in contact with a fluid into the filling fluid.

[0021] When the ultrasonic sealing apparatus of the present invention is used to heat seal, the width of the sealing zones, as aforementioned, generally matches the width of the pressing portions of the action face of the opposing jaw, while there is a mode in which the width of the pressing portions matches the width of the sealing faces of the horn, and a mode in which the width of the pressing portions is narrower than the width of the sealing faces due to the grooves for the resin bulges and/or the incline; and the ultrasonic sealing apparatuses comprising these modes are all included in the present invention. Further, in the ultrasonic sealing apparatus of the present invention, it is also possible to dispose continuous or discontinuous ridges on the pressing portions in correspondence to the sealing zones on the action face of the opposing jaw. The discontinuous ridges are disposed around the longitudinal sealing portions or on both exterior portions where the packing material is bent over, both of which cause steps and make the sealing pressure to be uneven, thereby preventing a sealing failure caused by tunnels from occurring.

[0022] Further, as aforementioned, in the ultrasonic sealing apparatus of the invention, a cutting device composed of a cutting edge and a driving means is generally disposed on the opposing jaw, because packing containers which are formed into a pillow-shape are to be cut off between the two sealed zones formed by heat sealing with a set of pressing members composed of a sealing jaw comprising a horn and an opposing jaw. Equally, as mentioned above, this cutting by the cutting device is normally done between the two sealed zones; however, a cutting apparatus can also be disposed below the ultrasonic sealing apparatus in order to cut approximately at the center of the broad sealed zones.

[0023] Heat sealing apparatuses according to the present invention will be described hereunder with reference to Figs. 5 and 6. Ultrasonic sealing apparatuses of the present invention, as shown in Figs. 5 and 6, employ a laminated packing material web 1 comprising thermoplastic resin layers and paper layers. A horn 12 has two elongated and flat sealing faces 11. An opposing jaw 18 has an elongated action face 16, which includes the pressing portions to press the packing material in corporation with the sealing faces of the horn, and a cutting device 17. As shown in Fig. 5, action face 16 of opposing jaw 18 includes grooves 20 that form molten thermoplastic resin bulges 19 in the vicinal area of the side of the sealed zones in contact with a fluid and grooves 22 that form molten thermoplastic resin bulges 21 in the vicinal area of the cutting side of the sealed zones. In the ultrasonic sealing apparatus shown in Fig 6, action face 16 of opposing jaw 18 includes grooves 20 that form the molten thermoplastic resin bulges 19 in the vicinal area of the side of the sealed zones in contact with a fluid, and inclines 23 that allow the molten thermoplastic resin to flow out of the sealing zones to the cutting side.

[0024] According to the present invention, even the

step portions around the longitudinal-sealed portions can be sufficiently heated by infallibly applying pulsation of the ultrasonic wave generating devices to the sealing zones; contaminants such as juice pulp existing in the sealing zones can be positively discharged from the sealing zones together with the molten thermoplastic resin; by controlling the thickness and the width of the molten resin that flows out to the side in contact with a fluid, formation of the undulated molten resin beads can be prevented; as a result thereof, an excellent ultrasonic heat sealing can be achieved.

BRIEF DESCRIPTION OF THE DRAWINGS

[0025]

Fig. 1 is a view explaining a process for forming a paper packing container by a conventional filling/packing machine;

Fig. 2 is a schematic perspective view of a heat sealed portion using a conventional heat sealing apparatus;

Fig. 3 is a schematic perspective view of an ultrasonic wave-generating device which can be used in an ultrasonic sealing apparatus of the present invention;

Fig. 4 is a schematic perspective view of an ultrasonic wave generating device of another embodiment which can be used in an ultrasonic sealing apparatus of the present invention;

Fig. 5 is a schematic longitudinal section of an ultrasonic sealing apparatus of the present invention; and

Fig. 6 is a schematic longitudinal section of an ultrasonic sealing apparatus of another embodiment of the present invention.

Claims

1. An ultrasonic sealing apparatus, wherein a packing material comprising a laminated body containing at least a thermoplastic resin layer is formed into a tubular form and the tubular packing material is transversely ultrasonic sealed with a fluid on the apparatus, comprising a horn having an elongated and flat sealing face and an opposing jaw with an action face comprising a pressing portion pressing the packing material in cooperation with the sealing face of the horn, and at least grooves are disposed on the action face of the opposing jaw, which can form the molten thermoplastic resin bulges in the vicinal areas of the sides in contact with a fluid of the sealing zones.

2. An ultrasonic sealing apparatus according to claim 1, wherein the grooves are disposed on the action face of the opposing jaw, which can form the molten thermoplastic resin bulges in the vicinal areas of the cutting sides of the sealing zones.

3. An ultrasonic sealing apparatus according to claim 1, wherein an incline is disposed on the action face of the opposing jaw, which can allow the molten thermoplastic resin to flow out from the sealed zones to the cutting side.

4. An ultrasonic sealing apparatus according to any of claims 1 to 3, wherein the width of the pressing portion is narrower than the sealing face by the grooves and/or the incline.

5. An ultrasonic sealing apparatus according to claims 1, 2 or 4, wherein the grooves are arcuate in cross section having a depth smaller than one half of the width.

6. An ultrasonic sealing apparatus according to any of claims 1 to 5, wherein the laminated body comprises paper layers.

7. An ultrasonic sealing apparatus according to any of claims 1 to 6, wherein the opposing jaw comprises a cutting device.

8. An ultrasonic sealing apparatus according to any of claims 1 to 7, wherein the tubular packing material is the tubular packing material formed into a tubular form by using a sealing tape, when the packing material is formed into a tubular form.

Fig. 1

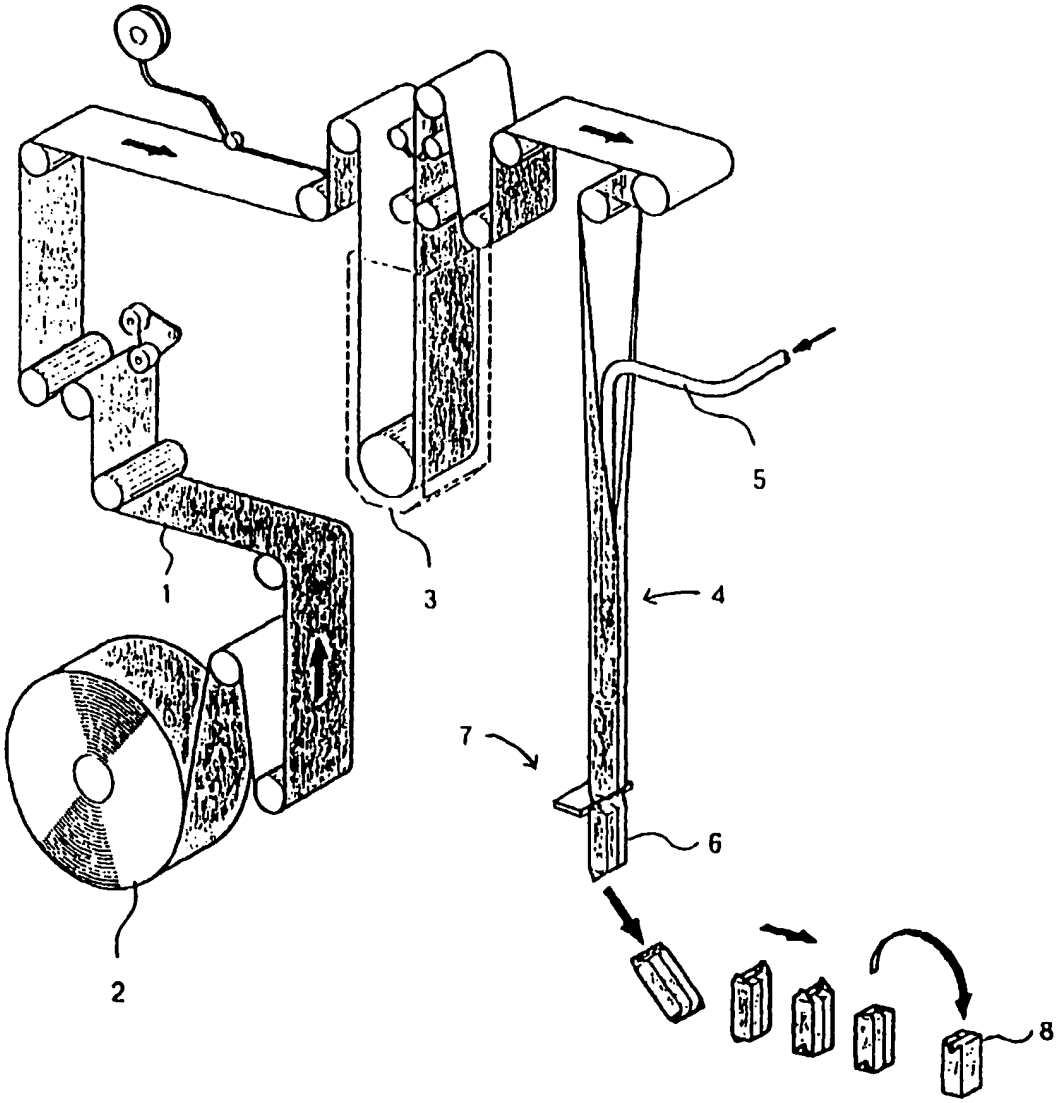

Fig. 2

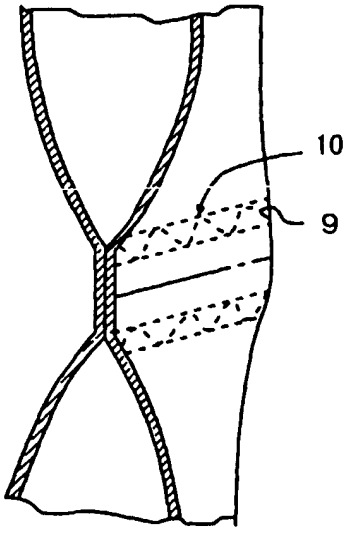

Fig. 3

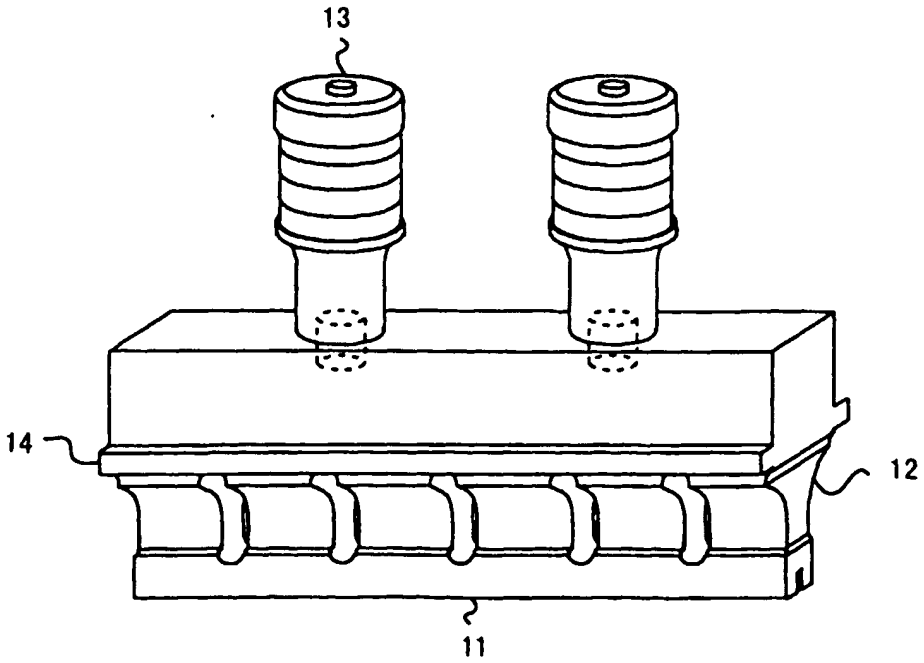

Fig. 4

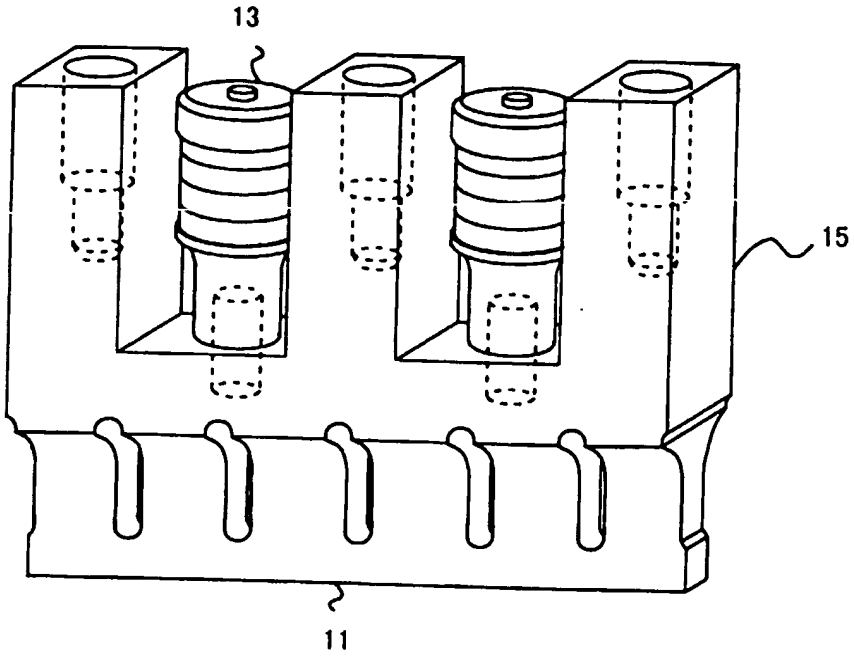

Fig. 5

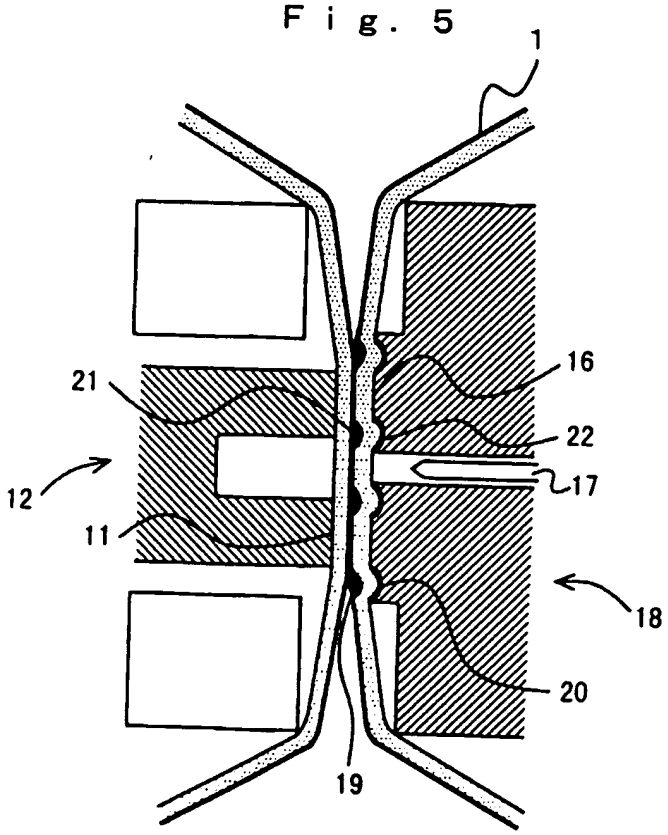

Fig. 6